Holotomography and artificial intelligence: from label-free live cells imaging to medical applications exploiting cell phenotypes

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Abstract

Holotomography (HT), also known as optical diffraction tomography, is a 3D quantitative phase imaging technique, which uses laser interferometry to provide the 3-D label-free imaging of live cells and tissues. As an optical analogous to X-ray computed tomography (CT), HT measures multiple 2-D holograms of a sample with various illumination angles, from which the 3-D refractive index (RI) distribution of the sample is reconstructed by inversely solving the wave equation. Unlike conventional fluorescence-based microscopy, HT provides label-free imaging capability, due to its utilization of refractive index as intrinsic imaging contrasts. Without any fixation or labeling, 3-D images of live cells and tissues can be obtained with high spatial resolution.

In this talk, we will present the principles of HT and applications. In particular, we will discuss the use of digital micromirror device for illumination control, and the potentials in medical applications, including the study of CAR-T cells interacting with target cancer cells and rapid label-free identification of bacterial species.

References

1. YK Park et al., Quantitative phase imaging in biomedicine, *Nature Photonics,* 12, 578–589 (2018)
2. Y Jo et al., Quantitative Phase Imaging and Artificial Intelligence: A Review, **IEEE** *Journal of Selected Topics in Quantum Electronics*, 25(1), 6800914 (2019)
3. MS Lee et al., Deep learning based three-dimensional label-free tracking and analysis of immunological synapses of chimeric antigen receptor T cells, *bioRxiv* preprint
4. G Kim et al., Rapid and label-free identification of individual bacterial pathogens exploiting three-dimensional quantitative phase imaging and deep learning, *bioRxiv* preprint